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GILBERT D. HARRIS, Geologist-in-Charge

NOTES ON THE GEOLOGY

OF THE

Winnfield Sheet

BY

G. D. HARRIS

Made Under the Direction of the State Experiment Stations

W. R. DODSON, Director

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NOTES ON THE GEOLOGY OF THE WINNFIELD SHEET

BY

G. D. HARRIS.

INTRODUCTORY REMARKS.

DESIRABILITY OF GOOD MAPS.

During the past seven years we have been slowly, yet persistently, paving the way to the construction of detailed topographic maps of certain portions, if not all, of the State of Louisiana. And this for the following reasons:

I. Good topographic maps furnish the prospective immigrant or investor the means of judging the character of the area or areas he may have in mind for settlement or financial operations.

II. In sparsely settled areas, good maps are of inestimable value to the traveler along the common highways. They save him the trouble and embarrassment of losing his way.

III. In projecting roads and railroads, a few minutes' study of a reliable map may save thousands of dollars in reconnoissance work.

IV. They furnish the basis whereon the distribution of soils, timber, mineral products and geological formations may be shown.

V. They furnish the basis for detailed studies in Physical Geography in all our more advanced high schools and colleges.

VI. Incidentally good maps serve as an index to the stage of social and financial development of the people ordering their construction.

The State Geological Survey is mainly interested in good maps because on them alone can detailed geologic features be correctly represented. Likewise, the United States Geological Survey has been interested in the construction of such maps, and, a large amount of its annual appropriations has been used for that purpose. The Bureau of Soils of the United States

Agricultural Department has also felt the pressing need of detailed maps and has often been obliged to devote much time and money to the construction of such maps as would serve as a proper basis for showing the distribution of soils.

CO-OPERATIVE MAP WORK.

It is very evident that when any kind of work is carried on by different organizations, State and National, for somewhat different purposes, the results obtained will be of a different kind and of varying general value or accuracy. It seems, therefore, highly desirable that one organization, or one government bureau, should at least set the standard if not actually control the constructional work. Economy demands this. All cannot map the same area to advantage to the State or Nation. In Winn Parish, a part of which forms the subject of the present Bulletin, the State Survey, the United States Geological Survey, and the Soil Survey have each made a substantial contribution towards the final mapping of the region. First the State Survey mapped with detail six townships in the immediate vicinity of Winnfield, townships as a rule known to contain mineral wealth, or points of unusual geologic interest. The topographic map herewith given (Pl. I) indicates the class of work and the area covered. Notice that the scale is the same as that used in the majority of work done by the United States Geological Survey, 1/62,500. The contour interval is also the same (20 feet). Heights are expressed in feet above mean sea level. But that this work might fit into the general scheme of quadrangular 15′ maps published by the United States Geological Survey, the writer suggested to that organization the desirability of accepting such portions of the area shown on Pl. I as could be used in a 15′ area and making such additions laterally as would serve to finish out a sheet of the ordinary standard type. This work is already well under way. The writer also urged the United States Soil Survey to study the distribution of the various soils in this region; the inducement held out to that organization being the detailed completed topographic map of at least six townships in the central portion of the area to be studied. This in turn led the Soil Survey to make further demands on the United States.

Geological Survey to furnish at least an outline map of the whole of Winn Parish, showing roads, streams, houses, though not at present showing contour lines. It is readily seen, then, that in consequence of the initiative taken by the State, the general Government has seen fit to do a large amount of work in this part of the State.

WHY THE WINNFIELD AREA WAS CHOSEN.

In many respects this area is typical of a greater part of the Hill Land of Northern Louisiana. There are many streams dissecting in a remarkable way the land surface, producing many steep, sharp slopes, but no hills as a rule over one hundred feet above the adjacent stream beds. Since, generally, the underlying sand and clay beds lie nearly horizontally, their outcroppings give rise along the gentle hill slopes to soils of varying character. Broad stretches of bottom lands are found adjacent to the larger bayous and rivers showing still different types of soil. The valuable hard wood of the bottoms and the pines of the hill land are disappearing as by magic with the advent of great "company sawmills." Great though the timber wealth of this region may be, calling for new roads and railroads running in every direction from the centers of lumbering activities, finally the soils must furnish the basis for the steady and permanent progress of this section of the country. But the Winnfield area had additional attractions. Here are building stone, limestone for plaster and cement works, salt, and perhaps oil and gas in paying quantities. So it appeared to us that the present mapping of this area might materially assist in the projection of roads and railroads, give information to outside parties as to the surface features of the land, furnish a basis for a careful soil survey of the region and induce the general Government to initiate work of that character here, serve as a basis for geological work now and hereafter, and finally serve the purpose of initiating map work in this part of the State, to be carried on more extensively as time goes on in co-operation with the United States Geological Survey. From what has already been said under "Co-operative map work" and elsewhere it is unnecessary to dwell on the fact that our most sanguine hopes have been more than realized.

TOPOGRAPHY.

FEATURES IN GENERAL.

No one can examine the topographic map herewith published (Pl. I) without being impressed with the smallness of the features exhibited. Or, on the ground, in following any given direction, a section line for example, one is constantly surprised at the great number of small steep slopes encountered. At one moment one finds himself in a narrow step-sided valley, at another on top of a divide, crossing some trail, path, or wagon road of some description, for the roads and trails in their earlier stages of development are almost invariably along the summits of ridges.

Again, one is often surprised at the great width of the bottom lands along the more important watercourses. Swamp conditions are by no means rare.

ELEVATIONS.

It will be observed that the lowest contour is but 80 feet above mean sea level, while in the western part of the map, especially in Sections 20 and 29 of the northwestern township elevations over 300 feet are indicated. In one instance there is a small area over 360 feet above tide. To the north and east elevations are low; to the south and west they are considerably greater. The bottom lands of Dugdemona River, as well as the low swampy plains along the lesser streams, all are very low, when their distance from the Gulf is considered, and especially when it is remembered that the Grand Gulf areas to the south and west have greater altitudes than the area here under discussion.

HISTORY OF TOPOGRAPHIC DEVELOPMENT.

With but very few and minor exceptions the topographic expression of the area under consideration is due to erosion. True it is that fresh exposures along streams and especially along the railways show that the underlying beds have been

uplifted and bent more in some places than in others, faults of a few feet throw can be seen here and there; but, there is no great amount of disparity in the resistance to erosion shown by any of the common sand and clay beds, and hence however complicated the stratigraphy may be the resulting topographic features are almost the same as though the whole country were composed of one great bed of clayey sand.

During Oligocene and Miocene, and doubtless during the greater part of Pliocene times this area was above sea level and was not receiving sedimentation. Doubtless, too, it was somewhat higher in later Tertiary times than now. Erosion went on apace during the later Tertiary, and we suspect some of the broader topographic features to have been outlined before the glacial epoch at the end of the Tertiary. The broad lowlands of the Dugdemona and the subdued and aged features for some distance on either side of the river; the extensive low, swampy bottom lands along such streams as Porte Luce and Cedar Creek, the present tendency of such streams towards aggradation rather than degradation: all show clearly that at some distant period, probably late Tertiary, this region doubtless stood higher above sea level than it does to-day, and hence erosion went on rapidly. Now, however, the country is so low that it is only the uppermost reaches of the streams that are doing erosive work.

There are, as stated above, a few very small areas that do not owe their present appearance to erosion alone. For example, the salt licks, with their light-colored, barren, level, floor-like stretches; the area of the so-called "Marble Quarry," with its sink-holes and recent upheavals; the depression known as Coochie Brake, and the elevation containing the sandstone ledge just to the north of the brake. These topographic features are due, primarily, to upheaving forces from below, or to the dissolving and transporting action of subterranean waters.

GEOLOGY.

MESOZOIC GROUP.

CRETACEOUS SYSTEM.

CRETACEOUS DOMES IN NORTHERN LOUISIANA.

General Remarks.—The earliest references to the Cretaceous rocks about Winnfield, or in the northern part of the State of Louisiana in general, are to be found under "salt licks," "salt works," "salt springs," or topics of like import, as already stated in full in our report of 1899, pp. 11, 13. The recognition of the fact that the salt areas were in part, at least, of an earlier age than the surrounding Eocene Tertiary beds was recognized by Robertson as early as 1865. The structure of these peculiar Cretaceous areas was first interpreted in a very simple manner—they were thought to be apices of Cretaceous islands, once forming a ridge or "backbone" around which Eocene deposition took place (Hilgard, 1869). In our Report of 1899 we indicated where organic movements had evidently taken place in Tertiary times in some of these Cretaceous outcrops. (See p. 58.) In our Report of 1902 the greater part of the salt licks in Northern Louisiana were described in great detail by Veatch. Their quaquaversal or dome-like structure was then quite fully made out. The immense quantities of rock salt beneath these licks, however was only surmised, and the real value of the "licks" scarcely appreciated.

A great boon to stratigraphic geology in our Gulf States has been the well records obtained subsequent to the discovery of oil in large quantities at Beaumont, Texas. "Salt licks," "islands," "buttes," "sour lakes," "quarries" or features that at once attract the attention in the usually monotonous sand and clay slopes of the Gulf Coast Tertiaries, by whatever appellation they may be characterized locally, seem to have this much in common—huge lenses of gypsum or limestone, or masses of rock salt, or both, located more or less centrally. The dip of the rocks about the periphery of such areas seems to be away from the central mass, often at a high angle. The longer we study these peculiar structures the more convinced are we that

although they may be located along lines of weakness, faults, or fractured anticlines, they are not to any great extent due to tangential, mountain-making forces, nor to volcanic upheavals, nor igneous plugs, as has recently been suggested, but to the slowly-acting, little understood, concretion-forming forces as well as the power of crystallization. Hot saline or calcareous solutions, coming from earlier Mesozoic or later Paleozoic beds beneath, rising perhaps by hydrostatic pressure alone, may very readily, upon reaching a level where the pressure is somewhat relieved and the temperature decreased, deposit some of their mineral contents.

Calcaceous concretions in shaly deposits in Paleozoic, Mesozoic or Cenozoic strata, seem to increase in size, bending adjacent shaly beds upward or downward with irresistible force, till the calcareous material within their reach, so to speak, is exhausted. If the supply were continuous, or not limited to the calcareous matter within a few yards radius, we see no reason why the concretion should not grow indefinitely. Though in some places there are Cretaceous limestones and sandstones, too, that have evidently been deposited in the regular way and contain well preserved upper Cretaceous marine fossils, no one, we think, can look upon the highly crystalline, cavernous, unfossiliferous Winnfield "marble" without a feeling that a great part of it has originated by some secondary process. Calcium carbonate has either leached into earlier calcareous beds laid down in the ordinary way, and has changed and inflated them beyond recognition, or has come into its place wholly by concretionary processes. In either case we believe the swelling up of this material, primarily Cretaceous, is largely responsible for the Winnfield quarry dome, and that vulcanism in its usually accepted sense has had nothing to do with the case. Igneous plugs and dikes usually cause great irregularities in the earth's magnetic field. How very slight are the irregularities in the Winnfield area may be seen by consulting Plate II. It would seem that perhaps a fault or a nearer approach of material of a different character from the ordinary Tertiary sands and clays is indicated by the trifling deflection of the south end of the needle towards a line indicated by heavy dashes on this Plate II. Deflections like these, detectable only by in-

struments specially constructed for terrestrial magnetic work, are scarcely of the kind that would be found if igneous activities had been at work in the region. The form of a dome depends, doubtless, largely on the position of most rapid increase in size of the formative masses, and this doubtless depends on lines of weakness in the superjacent strata. Some small areas may be so lifted that faults occur and the "lake" at the "marble" quarry and the expanse of water at Coochie brake, alongside of prominent upheavals, are doubtless to be looked upon as the downthrow side of faults of this kind. Sub-domes may be expected in a domed area. The apices of these minor domes, by their proximity to the surface and salt centers cause the minor barren tracts that go to make up the districts known by some such special name as "Cedar Lick," "Drake's salt works," and so on.

Cedar Lick.—After the past six years of prospecting with the drill about the various "islands," "sour lakes," "salt licks," "buttes" and so forth, we believe no one will dispute the extremely local character of the masses of rock salt found so generally beneath the localities designated by any of the above-mentioned names. Hundreds of feet of pure rock salt are found in some drill-holes, while less than a mile away even salt water may not be found at much greater depths. In the particular area under discussion, drilling had not at the time of our last visit been done in a sufficiently trustworthy manner to prove the position of the rock salt masses. But that they do exist beneath Cedar Lick (at no great depth, in some places, in case the region were properly explored) cannot be doubted. Similar structures but a few miles to the northwest, at Drake's old salt works, prove this, even if the extensive brine springs in the vicinity left any chance for doubt on the subject, for as a German writer has said, "Brine springs are the finger-posts to rock salt deposits." Enough boring has been done, however, to prove that in some places at least, over the salt mass there are thick layers of calcareous rock, often cavernous and containing considerable quantities of gas. About the periphery of each small "lick" in the Cedar Lick district there are slight elevations, somewhat higher than those a little farther away from the center of each

lick, so, although there are no actual rock outcrops in the district, some points in its stratigraphy can be surmised.

Good well sections in Cedar Lick, as we have said, are wanting. Not that no borings have been made in the region, but because of carelessness on the part of those interested to properly keep a log of the well, or desire on the part of the drillers to not let the public know how deep the drill was actually going, or what it was passing through. This much, however, is well established. Drilling has gone to a depth of at least 700 feet. Besides brine, gas has been met with in considerable quantities, so much so that a comparatively shallow vein has furnished a steady flow for over two years. When lighted the flame would furnish heat for a small boiler. It has gone to waste, however. The specimen of rocks encountered appear very much like the calcareous strata in the oil wells farther south, though in some cases here they appear to be extremely hard, suggesting even the ocurrence of chert nodules. These hard rock layers are said to alternate with sands and clays. In no specimens obtained from these drill-holes have we ever seen the slightest trace of organic remains. We are under the impression that they form lenticular concretionary masses whose origin has been referred to on a previous page. In Fig. 1, page 12, we have constructed an ideal section to show graphically our interpretation of the structure across the region of salt licks usually spoken of collectively as "Cedar Lick." Notice the licks themselves are represented as level tracts of land. Plate III shows something of the levelness and barrenness of these salty tracts. Here and there about their periphery are slight mounds, shown somewhat exaggerated by "H" in Fig. 1. At Goldonna, a few miles off our map to the northwest, in the old Drake Lick already spoken of, a well penetrated 300 feet of loose material, perhaps Quartenary or Tertiary sands and clays, then passed through 600 feet of limestone or gypsum, and then 1,400 feet of rock salt, finally ending in gypsum. And we believe Cedar Lick would show something the same section if boring were sufficiently prosecuted, though the lenticular masses of secondary material seem to be more prevalent here and the solid calcareous layers less persistent. The humps "H," in our estimation, owe their origin to

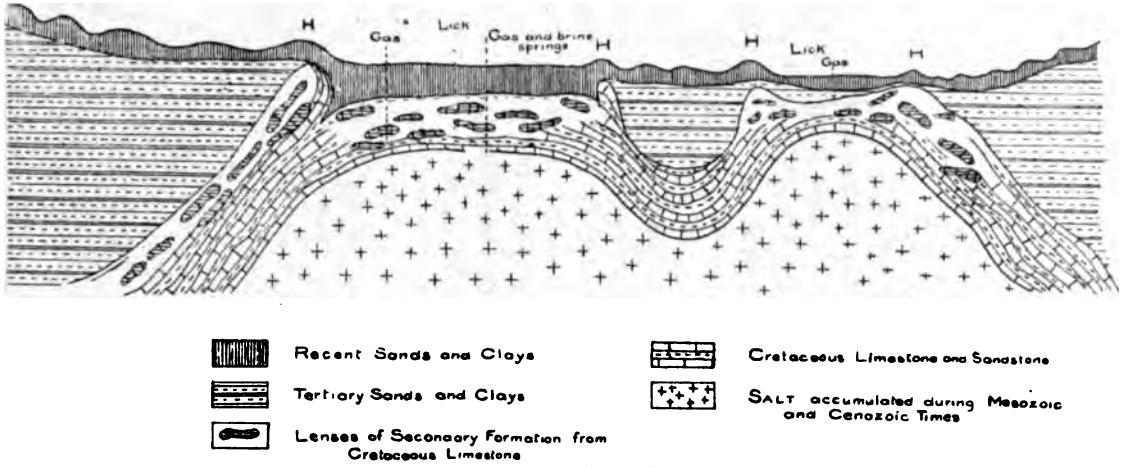


Fig. 1—Supposed structure of the rocks under Cedar Lick.
The Tertiary sands and clays should doubtless bend upward on approaching the Cretaceous uplift.

VIEW OF A PORTION OF CEDAR LICK. NEAR WINNFIELD LA. —Harris Photo.

either the presence not far below the surface of the upturned edges of indurated Cretaceous strata or calcareous material formed in a secondary manner from the Cretaceous material below, or perhaps to the outflowing of brines, or gases carrying and piling up arenaceous material in the form indicated. At Anse-la-Butte, in Southern Louisiana, the gravel and sand penetrated in the "hump" was said to be mixed with salt seams and lenses. At Rayburn's Lick fossiliferous Cretaceous strata are seen about the edges of the lick, as already described by Veatch. The gas that is generated in the lateral slopes of these domes works its way toward some fracture, pushing waters before it that have been rendered salty by being in proximity to the salt masses, and finally produces at the surface gas-brine springs—briny waters through which gas continuously bubbles.

Winnfield "Marble" Quarry.—We have discussed this locality in some detail in our Report of '99, pp. 56-58, and given some of the theories already advanced to account for this strange outcrop. These need not here be repeated, for the report referred to is accessible to all who write to the Director of the Experiment Stations for a copy. For convenience sake, however, we have inserted here the little detailed sketch map of a square mile around the quarry, made by Veatch and the writer eight years ago. The position of many little topographic characteristics are there shown much more clearly than on the small scale map, Pl. I. The photograph of Chimney rock we also repeat, Pl. IV.

Though the vertical part of the limestone outcrop at the Chimney may not be over 30 feet, one can, by properly searching in depressions and then following the beds upwards and beyond the top of the Chimney, find between 50 and 60 feet of strata exposed. It would seem from the locality shown in the photograph that the bedding planes (if such they really are) are nearly horizontal; by following the ridge a little to the northeast it becomes apparent that there is a very marked dip to the northwest. This seems to hold good to the Claiborne limestone outcrop, to the north on the bayou. In the bluff east of the bayou the dip swings around to the east. The small outcrops to the southwest are very unsatisfactory so far as showing direction and amount of dip. But the general impression obtained

from oft-repeated visits to all the various outcrops is: that upon the whole their dips and positions indicate that the uplift here recorded is elliptical dome-shaped, with the major axis running northeast-southwest; that this dome is fractured along its major axis, and that upon the whole the southern side of the fracture suffered depression while the northern remains well up with a monoclinal slope to the west of north. Something as to the dome-like structure of this vicinity can be gathered from the known outcrops of fossiliferous Claiborne beds as shown on the large map, Pl. I. The lake-like body of water to the southwest, as well as the swampy depression to the northeast of Jerusalem Church may have been caused in part by the orogenic movements more clearly recorded in the "quarry."

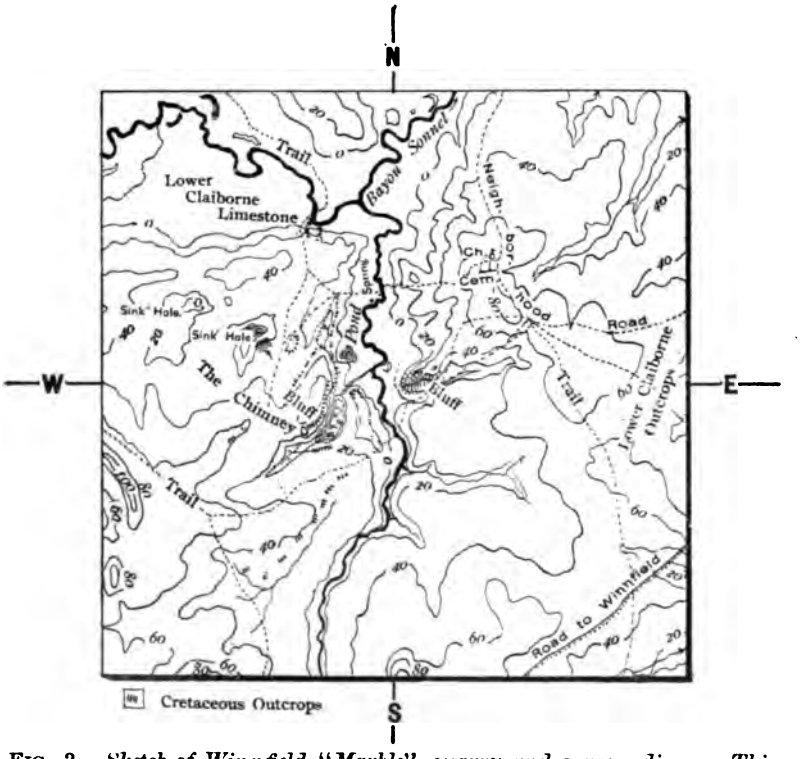


FIG. 3.—*Sketch of Winnfield "Marble" quarry and surroundings. This map embraces one square mile. Elevations are denoted by contour intervals of 20 feet, commencing with 0 at the base of the eastern bluff.*

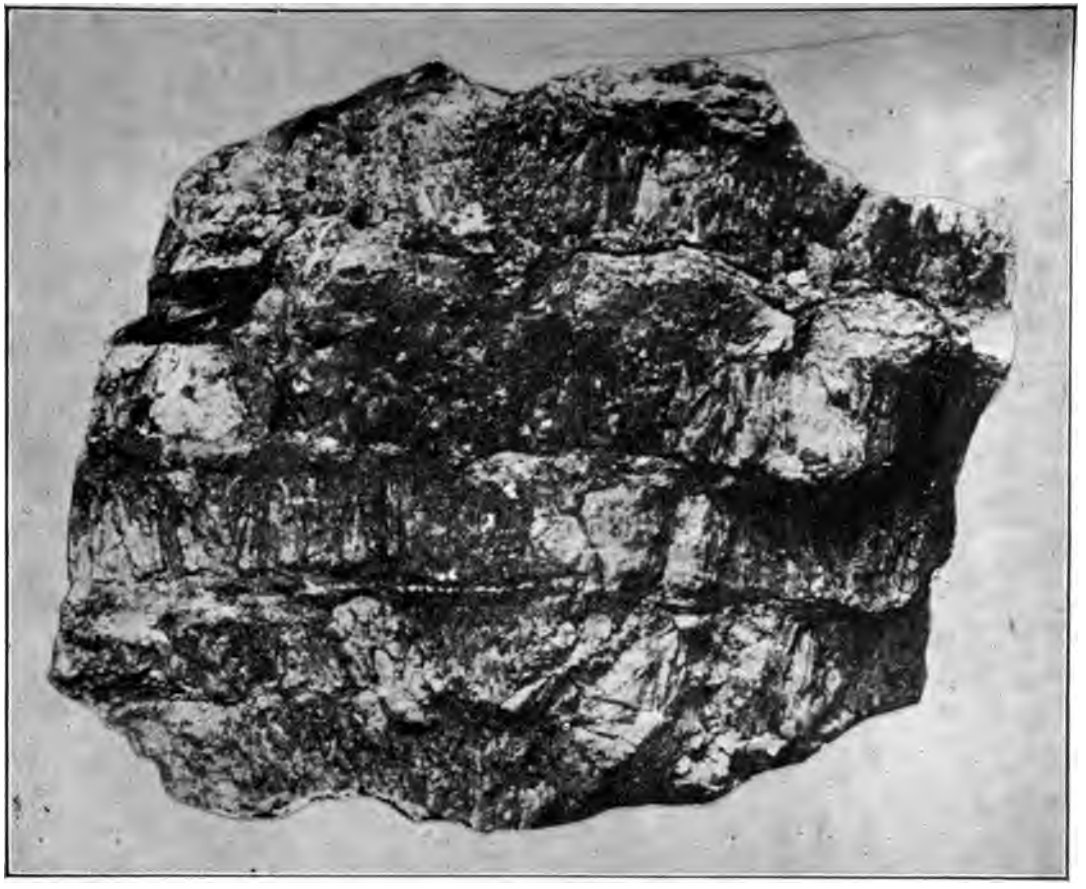
CHIMNEY ROCK, WINNFIELD "MARBLE" QUARRY, NEAR WINNFIELD, LA. Harris Photo.

Throughout the 50 or 60 feet of limestone beds here exposed we have endeavored to see some change in rock character, but with practically no success. In some places, however, it seems as though the white and blue alternating laminæ differ in such a way in thickness that the blue are relatively more noticeable the lower one goes down in the section. The thick seams made of dog-tooth spar (Pl. V) have certainly been seen most abundantly near the top of the section, east of the bayou.

Perhaps one of the most interesting points relative to this vicinity is the occurrence in peculiar pockets in the bluff east of the bayou of a red, granular, porous limestone. The calcareous crystals are nearly transparent and glitter like fragments of glass. Among this reddish granular mass are remains of insectivorous mammalia and mollusks apparently of a land fauna.

The bold escarpment here referred to has nothing to suggest the former presence of a cave in this vicinity. But, there can be little doubt but that in Tertiary or Quaternary times the limestone beds were more extensive and contained caves in which this reddish limestone was deposited in the form of calcareous sinter, or partly, perhaps, after the manner of stalagmites. The very remarkable feature about this cave limestone is that in many places it is replete with minute long, hollow bones, evidently the finger bones of some species of bat. Occasional lower jaw bones are also found; sometimes tiny bones of other parts of the skeleton.

The comparatively recent age of this limestone is attested by the fact that it was formed in cavities in the common white and blue limestone of this locality, which latter as shown by the fact later on, has been more or less modified since Claiborne Eocene times; the great age, in years, is attested by the fact that although this limestone was formed in a cave, all traces of cave structures have disappeared.



A SPECIMEN OF WINNFIELD LIMESTONE, BANDED BLUE AND WHITE, SHOWING DOG-TOOTH SPAR.
(*Two-thirds natural size.*)

Coochie Brake.—This interesting locality is in the very southwestern corner of the map, Pl. I. Something as to the nature of the "brake" and the amount of valuable timber it contains have been given in our Report of '99. In that report too the outcrop of heavy sandstone beds was noted. Unfortunately we were told that the rock just referred to was somewhat differently located as to the land lines than we have more recently, by our own surveys found to be the case, but the remarks as to extent of outcrop, dip, and so forth made then are quite correct. Herewith we give (Pl. VI.) a somewhat different view of the rock outcrop, looking northwest instead of northeast, as in the plate shown in Report '99. The geologic structure of this locality is doubtless as already intimated, due largely to the swelling of gypsum or salt beds underneath causing here a fault or fracture in a northeast-southwest direction. The "brake" would seem to occupy the downthrow side of the fault, the rocky outcrop, the northern. Were it not for the underbrush and talus, the edges of the very heavy, apparently level beds could be well seen on Pl. VI. In mounting the escarpment shown, and looking toward the northwest it is at once obvious that the whole formation plunges beneath Tertiary sands and clays in the lowlands only a few hundred yards away. Although the rocky layers come to the surface for a distance of less than one-eighth of a mile, their presence is manifest by the soil-covered ridge extending nearly half a mile in a northeast-southwest direction, as may be seen by consulting the map. Again, although not over 40 feet of rocky ledges are to be seen in any one vertical escarpment, there is little doubt that the same material extends some distance below the top of the talus slope.

No animal remains have been found in the Coochie Brake beds. Fragments of wood and leaves are in places common. The most characteristic feature of the outcrop is the red iron stains due to the presence of large numbers of iron pyrites nodules.

—Harris Photo.

CALCAREOUS SANDSTONE OUTCROP AT COOCHIE BRAKE, ABOUT FIVE MILES WEST OF ATLANTA, LA.

CENOZOIC GROUP.

TERTIARY SYSTEM.

EOCENE SERIES.

SABINE STAGE.

Distribution and characteristics.—Just beneath the fine outcrop of fossiliferous Claiborne limestone to the north of Chimney rock at the Winnfield quarry there appear at least 30 feet of lignitic clay, dipping at an angle of from 10° to 40° in a westerly direction. Since the Claiborne limestone contains a very similar fauna to that of the calcareous marl at Natchitoches, and since there, too, dark, lignitic clays occur beneath the fossiliferous beds, and these we have referred to the Sabine stage, there seems to be no reason why the clays at the Winnfield quarry should not be referred to the Sabine, though as yet they have yielded no characteristic fossils. There are a number of species of fossil plants here, but thus far they have not been studied.

By consulting Pl. I it will be observed that the fossiliferous Claiborne surrounds the quarry in a more or less circular manner. Between the limestone outcrops and the Claiborne beds the strata are generally hidden by surface soils, but occasionally as in the banks of Rocky Bayou, south of the quarry, south of the highway, perhaps 150 paces south of "B. M. 152," some fine lignitic clay beds can be seen dipping east or in the opposite direction from the dips of the Sabine clays north of the quarry.

CLAIBORNE STAGE.

Distribution and characteristics.—Nearly all the area represented on our map is referable to the Claiborne stage. The Cretaceous and Sabine outcrops are very insignificant. In the southeastern part of the area certain gypsum-bearing clays and sands should probably be referred to the Jackson stage. East and northeast of Packton the water from shallow wells is impotable, and we have no doubt but that if there were a large number of excavations made in this district somewhere fossils would be found and they would most probably be of the upper Eocene or Jackson horizon. (See discussion below.)

West of the Mississippi River the Claiborne stage is usually

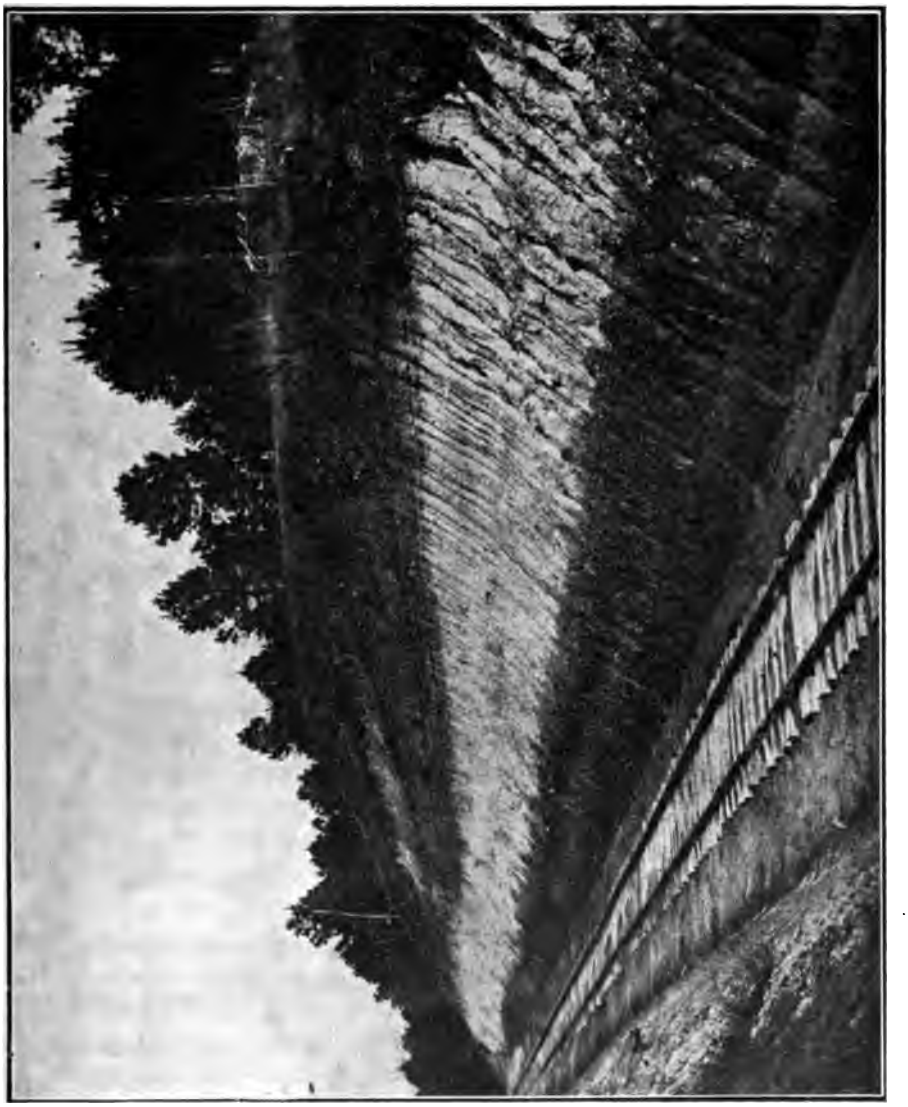
divisible in two parts, the lower, as a rule, quite fossiliferous, and the upper, often called the Cockfield sub-stage, quite barren so far as zoogene fossils are concerned, though abounding in fossil plants and lignitic clays.

The lower fossiliferous substage of the Claiborne is fairly well shown in the northwestern portion of the map, especially about the so-called "Marble" quarry. West of our map, in the vicinity of Couley, and north of the map, from Tannehill northward, this lower fossiliferous member of the Claiborne can be seen and studied. The greater part of the area mapped, however, must be referred to the upper, lignitic division of the Claiborne stage.

The Sabine beds exposed beneath the Claiborne limestone to the north of the "Marble" quarry have already been referred to. The lignitic clays give place above to calcerous clays of a light color, with here and there a mass of ferruginous sandstone. On the bottoms of these sandstones are found besides oyster shells, *Byssoarca, Capulus, Venericardia, Corbula, Lucina* and other marine bivalves. Still higher comes the great cream-colored limestone with its numerous oysters, *Byssoarca, Pseudoliva,* and a Nummulitic form in great quantities. This limestone is 8 or 10 feet in total thickness and dips westward at an angle of nearly 45°.

Practically all the lower Claiborne outcrops besides the one just described consist of calcareous, or red, ferruginous sands or sandstone beds. Occasionally, however, as in the prairie region 3 or 4 miles southwest of Calvin, light calcareous clays come to the surface and oyster shells can be picked up, not as mere casts, but in a well preserved condition. On the Montgomery road just south of the "Marble" quarry the highly ferruginous red fossiliferous sandy layers are well shown.

The thickness of the lower fossiliferous member of the Claiborne is probably not great, possibly not over 100 feet. Still, estimates of thickness are very unsatisfactory here owing to the few exposures that can be seen and studied. From the Atlanta well as given below it appears that 100 feet can be safely referred to this lower division.



DEEP CUT ON THE "VALLEY" ROAD THREE MILES SOUTHWEST OF WINNFIELD, LA.—Harris Photo

The upper or Cockfield member of the Claiborne is finely exhibited along the various railways crossing the area shown on the map, as well as in the upper reaches of the more important bayous. Sand and clay of a light hue generally, though darkened occasionally by lignitic material, constitute practically all this sub-stage of the Claiborne. Hardened or consolidated material is rarely met with. Fig. 3 shows how the first 300 feet of the L. & A. railway well at Winnfield penetrated nothing but alternating beds of sand and clay. The few thin rocks and the alternating or intermingled sands and clays below probably belong to the lower portion of the Claiborne and to the Sabine. No fossils were reported from this well. No detailed record seems to have been kept of the character or color of the various beds penetrated. However, by going on the "Valley" railroad about 3 miles toward Atlanta from Winnfield an excellent exposure can be seen of the upper Claiborne beds. A good view of the south side of the cut is herewith given as Plate VII. The different beds shown are as follows, beginning above (see Fig. 4):

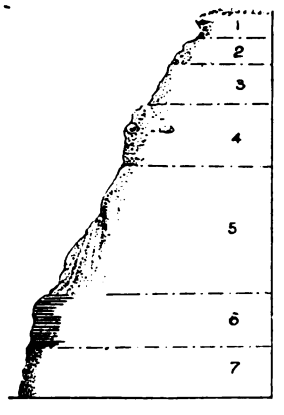


FIG. 4.—Diagram of the beds exposed in the cut shown in Plate VII.

	Feet.
1. Soil, red above	2
2. Sandy clay	2
3. Light sand	3
4. Sand, clay partings, with ferruginous concretions	5
5. Light sand, yellowish lines	10
6. Dark clay with leaves	4
7. Dark sand	4

As a rule, the sections along the "Valley" railroad show little variation in appearance and but few interesting structural features. At Atlanta, however, the Germain & Boyd Lumber Company put a well down 877 feet deep on the high hill just east of their mills, in section 26, perhaps three-quarters of a mile north-northeast of New Atlanta. The section furnished by this company reads as follows:

First 10 feet red clay mixed with sand.
From 10 feet to 30 feet white clay.
From 30 feet to 60 feet hard blue clay.
From 60 feet to 66 feet fine sand.
From 66 feet to 120 feet hard blue clay.
From 120 feet to 122 feet 8 inches hard rock.
From 122 feet 8 inches to 129 feet clay.
From 129 feet to 135 feet sand and clay.
From 135 feet to 229 feet blue clay.
From 229 feet to 241 feet sand.
From 241 feet to 270 feet hard clay.
From 270 feet to 287 feet coal or shale.
From 287 feet to 380 feet clay.
From 380 feet to 394 feet sand.
From 394 feet to 401 feet hard clay.
From 401 feet to 421 feet sand and soft clay.
From 421 feet to 475 feet hard clay.
From 475 feet to 503 feet hard clay with large boulders every few feet with small shells.
From 503 feet to 543 feet hard clay and boulders every few feet.
From 543 feet to 580 feet clay, shells and a little fine sand.
From 580 feet to 585 feet rock, clay and shells.
From 585 feet to 609 feet sand rock.

"We have no record below 609 feet; the total depth of the well is 877 feet; as I can remember it, it was sand rock below 609 feet most of the way until they struck the salt water 36 feet from the bottom; this was the first salt water struck. We went through a small stratum of sand from 380 to 394 feet containing fresh water."—GEORGE H. BOYD.

By searching in the sand that was said to have come from a depth of 500 feet we were able to obtain several small but typical lower Claiborne fossils.

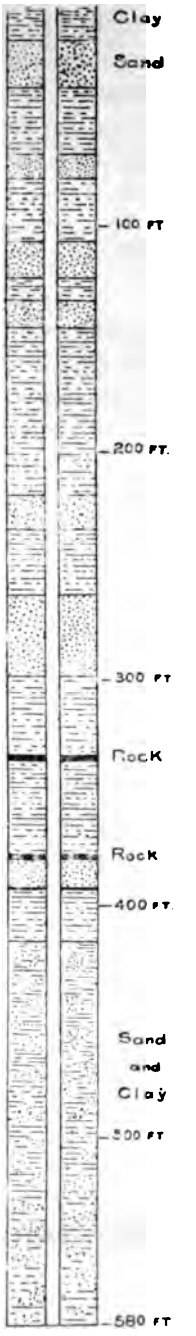


FIG 3—Well section at L. & A. railway station Winnfield, La.

The top of the fossiliferous beds here may be placed at approximately 200 feet below tide level. Nine miles to the north-northwest the uppermost fossiliferous beds seen were approximately 240 feet above tide. Hence the dip between the latter place and the Germain & Boyd well must be about 440 feet. Were it not for the Winnfield-Coochie fold that we have described as crossing this line of dip (see Plate II.) we believe the dip should be twice the amount just given, or even more, as will be apparent when the sections below are considered.

Section in Winnfield.—Just south of where the Georgetown road crosses the Arkansas Southern railway track, over a high bridge, about 20 feet of Tertiary strata are exposed. They appear to have a steep southern dip amounting to about 8 feet in 100; are of a light gray and yellowish hue, and show no very distinct and well-defined bedding. All may be called a clayey sand, with but comparatively unimportant differences.

Section along the L. & A. railroad, from Winnfield to Moore. - -Outcrop No. 1 (see Pl. VIII).—About one-quarter mile south of the trestle or the letter B in "B. M. 103" on the map, on the west side of the track one can see no less than 20 feet of very dark lignitic clay below the rails in the knolls excavated by the railway company for embankment purposes. Very little dip is here observed.

Outcrop No. 2.—About one-half mile north of "B. M. 133"—The depth and length of this cut can be ascertained by consulting Pl. VIII. At the north end cross-bedded sands occur; to the south beds of sandy clay form an arch or anticline.

No. 3.—One-third mile south of "B. M. 133."—This cut is characterized by its reddish sands. At the southern portion irregular bedding and flow-and-plunge structure are noticeable. The red sand beds often show white clay layers and pellets along their lines of parting.

No. 4.—Just south of "B. M. 107."—An old stream channel, ocupying the northern third is the most interesting feature of this cut. It shows occasional pockets of Pleistocene gravel The lower part of the cut, to the south, is occupied by typical lignitic sandy clays with thin yellow sand and ferruginous sandy partings.

No. 5. Several small cuts occur along the railway to the

No. 5.—Several small cuts occur along the railway to the south of Cedar Creek, but the most interesting is the one about half-way between "B. M.'s 131" and "163." Here may be seen two rows of "bomb-shells," about 3.5 feet apart vertically, and averaging perhaps 20 feet apart horizontally. These "bombs" are clay-ironstone concretions, of a deep red hue, sometimes a foot or more in diameter. The greater part of the exposure is made up of light sands with yellowish partings. Toward

FIG. 5—"Bomb-shells" on the L. & A. railway between Moore and Winnfield, La

the base more clay occurs and a tendency toward a chocolate hue appears. (See Fig. 5.)

No. 6.—On bank of stream just south of "B. M. 163."—Here is an extensive exposure of light grayish or olive sands with an apparent dip of one-sixth to the S. S. E. Cross-bedding is frequently seen. Great ferruginous concretions are imbedded in the light sand. Some concretions are of a very yellowish hue and seem decidedly calcareous.

No. 7.—Just north of "B. M. 186."—An uninteresting cut of sandy layers, dark above, lighter below, dipping slightly to the north.

No. 8.—Just to the south of "B. M. 186."—Three rather distinct layers are observable in this cut. Above are 8 feet of sand, becoming dark, to the south. In the middle are whitish clayey sands with blackish partings, 8 feet. At base are 10 feet of light clayey sands, slightly brownish in places, with yellowish partings.

No. 9.—One-half mile south of "B. M. 186."—A shallow cut of about 10 feet showing below reworked material, about 5 feet of cross-beddded scaly clays, with a slight dip to the south.

No. 10.—One-half mile north of Moore.—A cut 20 feet dep consisting of whitish and yellowish sandy layers separated by ferruginous scaly seams, slightly cross-bedded at north end of cut. Dip southerly about 1÷100.

No. 11.—In the west railroad ditch, about one-quarter mile north of Moore.—Light olive sands, about 20 feet exposed. Dip southerly, perhaps 1÷15.

No. 12.—At Moore, South from the road crossing.—An excellent exposure, showing interesting structural featurees. See Fig. 6: a, 7 feet of orange flecked white sand; b, light reddish sand; c, light sand 7 feet; d, concretions; e, 8 feet light sand

FIG 6—Details of cut at Moore, La.

with vertical ferruginous partings; f, lignitic sand, 3 feet; g, sands, sometimes purplish from decayed "bomb-shells", 5 feet; throw of faults, from 2 to 8 feet; direction of fault, E. 15° N.; hade, 20° to 40°. Downthrow on north side.

No. 13.—One-half mile to the south of No. 12 there is a low cut about 800 feet long showing at base light sandy clays, dipping 1÷15 southward; above are light reddish clayey sands, light yellowish when weathered.

There are no more cuts of importance to the south on this railway before the southern limits of our map are reached.

Cuts on the Arkansas Southern railway, south of Winnfield.—By consulting Plate VIII it will be seen that the exposures shown furnish but samples, as it were, of the strata that underlie this general region. It has not been possible to state which beds seen along the L. & A. are to be correlated with which on the Arkansas Southern. In fact, doubtless the majority of the beds seen on the one are not exposed on the other. Still, after arranging the manuscript notes of a section along the latter road in the same way we have arranged those along the L. & A., it becomes apparent that they agree in materials exposed, in cross-bedding, faults, jointing, etc., that is there are no materials in the one not shown in the other, but the identification of the same bed or the same structural feature on both roads cannot well be made, though the roads are very near together. The materials of which the upper Claiborne beds are made are subject to marked variations in very slight distances.

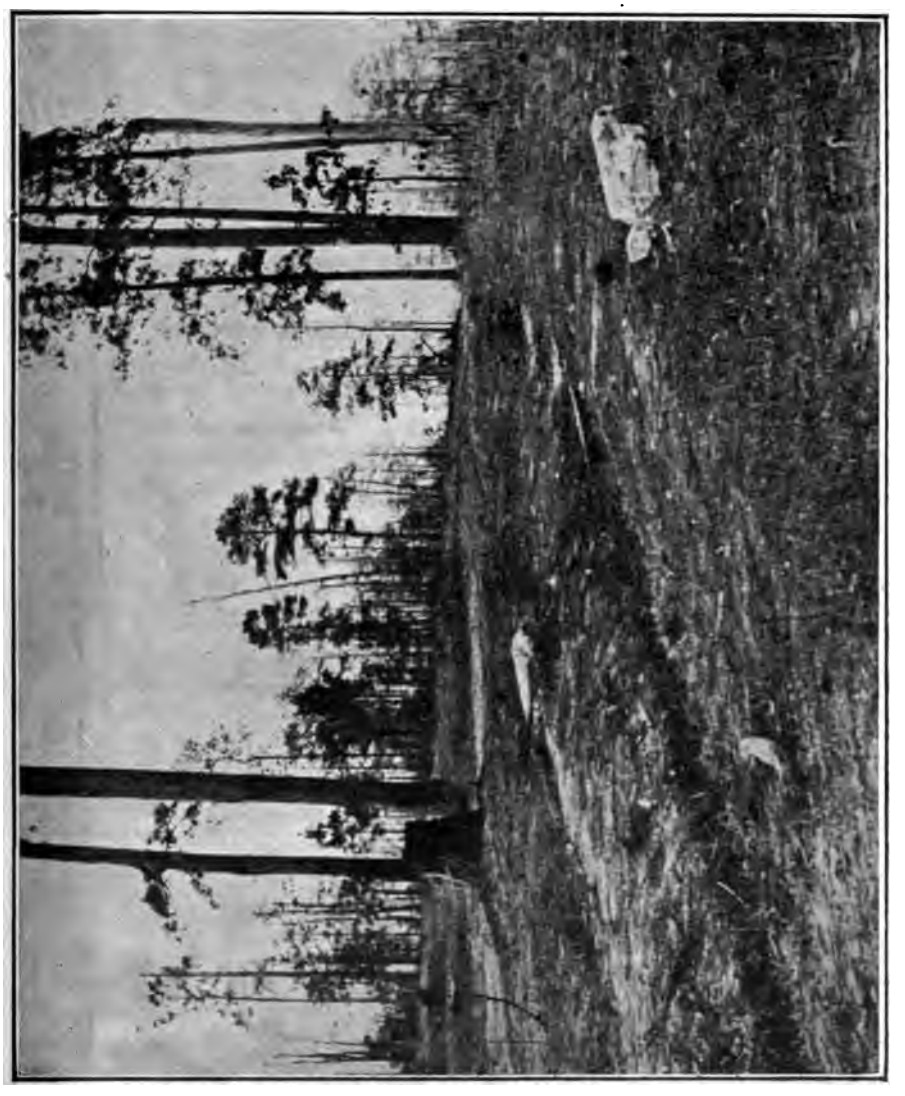
Thickness of the upper Claiborne deposits.—From dip calculations along both the L. & A. and the Arkansas Southern we have found that the thickness of the upper unfossiliferous portion of the Claiborne must be at least 1,000 feet to the south of Winnfield. But if we add 400 feet more as the well section at the L. & A. station would seem to call for, we have a total of 1,400 feet as a minimum. This seems excessive, but when we realize that the fossiliferous lower portion of the Claiborne is perhaps not over 100 feet thick, the total for the Claiborne is 1,500 feet, still somewhat in excess of previous estimates for this stage in Louisiana, but one that present indications would show to be a minimum rather than a maximum figure.

JACKSON STAGE.

The presence of this stage in the area represented by the map has not been proven by fossil remains. We have indicated the probable occurrence of Jackson beds in the southeastern corner of this area because just over the parish line south of Prairie Home P. O. well preserved Jackson fossils occur. The strike of the beds here is a little north of east, so that the boundary line between Jackson and Claiborne stages might well be expected to pass across the southeast corner of our map. The general occurrence of extremely "bad" water with marly clays containing quantities of selenite crystals in the vicinity of Pleasant Hill Church and between here and the parish line to the south suggest materials and conditions of depositions much more in harmony with the Jackson than the upper part of the Claiborne stage.

QUATERNARY SYSTEM.

Little is known of the condition of affairs in central Louisiana during the Tertiary after the Jackson stage. The Oligocene, Miocene, and, perhaps, Pliocene are not recorded by any recognizable materials of deposition. This area was most probably much higher during the middle and upper Tertiaries than it is to-day. Doubtless, as we have already remarked, some of the main topographic features were outlined before the end of the Tertiary. Yet, much of the region herewith mapped is characterized by sharp and youthful topographic features, and erosion is going on apace in the upper reaches of the main streams. Hence, doubtless, all of the minor topographic features were wrought during comparatively recent or Quaternary times. We strongly suspect that during the later Tertiary the whole Dugdemona valley was carved much deeper than it appears to be to-day and that a great amount of re-filling has taken place in Quaternary times. On the hill land there is a remarkably small amount of material that can be looked upon as having been transported far or as being re-worked to any extent from the Tertiaries below. In the cuts on the "Valley" railway but a short distance south of the station, five or six feet of unstratified material can be seen on top of the stratified Tertiary. Here, too, generally at the base of the former are numerous fragments of petri-



SCATTERED WOOD IN ROAD CUTBIT OF WINNFIELD, LA.

fied wood. Sometimes they may be seen as chunks or logs, but as a rule they are mere splinters, nearly always with sharp edges, showing little or no erosion. Fossilized wood occurs as logs of considerable size on the surface of the ground on the hills beyond the salt licks southeast of Winnfield. On the first hill south of the L. & A. station in Winnfield many of these petrified logs may be seen along the highway. (See Plate IX.)

Pebble beds, so extensively displayed in many regions on the Gulf slope, just at the base of the so-called "Orange Sand" of the old school of geologists, are comparatively unimportant in this region. We have already noted a few pockets with pebbles along the L. & A. railroad section; and others can be seen six or eight miles south of Winnfield on the Arkansas Southern. They are surprisingly insignificant in comparison with deposits of similar material in, for example, Catahoula parish, or Rapides, in the hilly regions. These pebbles are composed of chert and often contain Lower Carboniferous fossils. They evidently have been extensively water-worn, and oxidized to the last degree. They came from Indian Territory, northwest Arkansas, Kansas or Missouri, for their contained fossils show this, but the method of transportation is still not well understood. Along an old trail perhaps two miles northeast of Packton we observed a very large chert pebble or rock, at least eight inches in diameter. It is certainly difficult to explain its presence here without invoking the agency of floating ice.

ECONOMIC PRODUCTS.

WATER.

In a region underlain by very irregularly lense-shaped masses of clay and fine sand, containing joints, faults, and many local folds, there is no hope of meeting with a well-defined, easily recognizable water-bearing horizon, like the Potsdam or Dakota sandstone in the North and West. Again, underneath these irregular sand and clay beds there are anticlines and faults in the Cretaceous rocks, and the Cretaceous is locally pregnant with rock salt. Brines therefore may leach up through several hundred feet of the above-described clays and sands. The difficulties to be met with in supplying a town, for example, with

deep well water are therefore great. In spite of these discouraging features, however, water may be obtained in most places in abundance by utilizing whatever water is found in each sand stratum penetrated. Since these strata are numerous the supply from one well can be made very considerable. The Clifford Well Company obtained a supply at the L. & A. station at Winnfield of 90,000 gallons daily within 580 feet, from a 3-inch well. To go deeper than this would be to run the chance of striking salt water, especially in this particular vicinity, where we believe a Cretaceous ridge occurs at perhaps a depth not much greater than 1,000 feet. The same conditions prevail at Atlanta where the Germain & Boyd Lumber Company reached very bad, salty water at 841 feet. Its analysis is as follows:

"From Germain & Boyd, Atlanta, La., Winn Parish, submitted by Judge P. J. Patorno, 506 St. Philip street, city.

(Analysis expressed as grains per U. S. Gallon.)

Sodium Chloride	353.672
Sodium Carbonate	7.128
Potassium Sulphate	1.792
Potassium Carbonate	0.470
Magnesium Bicarbonate	8.126
Calcium Bicarbonate	12.886
Iron and Aluminum Oxides	0.139
Silica	0.435
Volatile Matter	Trace.
Bromine	Trace.
	384.748
Calculated excess water	2.448
Total	382.300

"Remarks—This water is decidedly salty and contains twenty-one (21) grains of incrustating material to the gallon. This water is unfit for boiler, technical, or domestic purposes. Its only use would be for extinguishing fires. This water energetically and actively attacks galvanized iron. DR. A. L. METZ."

To the south of Winnfield there should be no great difficulty in obtaining a good supply of water by utilizing whatever

each sand bed carries. In the very southeastern part of the area covered by the map doubtless the water obtained from the selenite bearing clays and sands to a depth of 50 to 100 feet would have to be cased off from the supply found in the good water-bearing sands lower down.

In the western part of the area mapped, west of the "Marble quarry," for example, in the long-leaf pine woods, the extensive superficial deposits of fine sand absorb immense quantities of rain water, and, whenever this reaches an impervious clay layer that lies above the valley bottoms, it comes out in springs of large size and most excellent quality for drinking purposes. A few of these springs we have noted on the map. Deep well water in this region should be obtained if desired, as in the area to the south of Winnfield. The region about Calvin presents somewhat greater difficulties as to deep well water, for the Claiborne beds near or at the surface would be more than apt to carry bad-tasting mineral waters. The Sabine stage is that which if properly worked would yield fair water at less than 600 or 800 feet. Depths greater than that would furnish, locally, at least, salt waters. To the northeast of Winnfield across the Dugdemona, there are so far as we are aware no deep wells, but there appears to be no reason why they may not be obtained as satisfactorily as at Ruston, for the formations encountered are alike in the two localities.

SALT.

The extensive salt licks a few miles southeast of Winnfield, as already described, leave practically no doubt as to the presence there of immense beds of rock salt within a few hundred feet of the surface of the ground. In exploiting this region for mining it is worth while to make sure of two things—first, that the location for a shaft is at the place where the salt approaches near the surface and, second, that the salt is capped with a considerable thickness of solid rock.

At Ithaca, N. Y., fresh water is turned into drilled wells sometimes 2,000 feet deep or more. After saturation from being in contact with the rock salt mass the water is forced up and evaporated by the exhaust steam from the street car power plant.

This use of superfluous heat about the many large Winnfield mills should certainly be considered by their owners. Again, in the Winnfield salt lick district the salt or brine springs, as well as the "oil" well already bored, prove the existence of no inconsiderable amount of gas in the region. The burning of such gas as can easily be obtained should also furnish a sufficient amount of heat for evaporating large quantities of table salt.

GAS.

A considerable amount of gas is escaping from the various brine springs in Cedar lick, and the "Blow-out" well has produced brine and gas for nearly two years. But, upon the whole, we are not inclined to think that immense quantities of gas are pent up in these salt domes. Such gases as have been generated in the district have had too easy ways of escape to have accumulated in large quantities, producing great gas pressure over large areas. Yet nothing short of actual testing with the drill will show how much gas may be obtained.

LIMESTONE.

We have had occasion frequently to refer to the so-called Winnfield "Marble quarry." The value of the material there shown as "marble" is but slight. As limestone for burning to quicklime and as an important ingredient for cement and soda ash manufacture its value is great. By comparatively little stripping, limestone rocks could be exposed for a distance of half a mile in a northeast-southwest direction and from an eighth to one-fourth mile in a northwest-southeast direction.

For the manufacture of cement, clays just beneath the Claiborne limestone to the north of the 'quarry." as already described, should be studied carefully. Other clays can be found exposed in railway cuts; for example, near the brickyard in West Winnfield or in the great cut shown as Plate VII. For the manufacture of soda, a test well should be first put down near the "quarry" in search of salt. It is quite possible that rock salt may be found beneath the limestone. However, by the construction of short tram lines or spurs from the "Valley" or the L. & A. railroad, limestone may easily be brought to Winn-

field and brine may be pumped there from the lick to the southeast. By consulting the map, Plate I, it is easy to see that with but one cut of importance a railroad could be laid out from, say, "B. M. 184" on the Montgomery highway east joining the "Valley" railroad at "B. M. 153." Connections from the quarry down the bayou to "B. M. 112" or "113" on the L. & A. could be readily made.

BUILDING STONE.

The bluff of calcareous sandstone (often heretofore improperly called limestone) is of excellent quality for construction purposes, but, owing to the pyrite concretions it contains, it could not well be used for facing or ornamental stone work. Some have supposed the quantity of this sandstone to be limited to what is in sight now at the "brake." The topography to the northeast, however, indicates clearly that by stripping, a quarry one-half mile could be opened up.